

U.S. Serial No. 10/019,407

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REMARKS

Reconsideration, as well as favorable action of the above-identified application, is respectfully requested.

In the outstanding Office Action, a newly formulated art rejection was given regarding independent claim 3. Claim 4, which depends on claim 3, however, again has been indicated as containing allowable subject matter and that it would be formally rendered allowable upon being re-presented in an appropriate self-contained format. Since Applicants consider the invention according to base claim 3 as being defining also over the newly cited reference, Applicants consider, therefore, that the re-presenting of claim 4 as an independent claims, at this time, is not necessary. In this regard, it will be shown below that the invention according to claim 3 was neither disclosed nor could have been suggested from Noguchi et al (USP 6,172,380), which was newly applied. Accordingly, the rejection of claim 3 under 35 U.S.C. §102(e), allegedly, as being anticipated by Noguchi et al is traversed and withdrawal of the same is respectfully requested.

The present invention sets forth a schemed semiconductor device in which the plural transistors thereof are formed in a polycrystalline semiconductor thin film and, also, requires that the polycrystalline semiconductor thin film be structured in accordance with plural laser irradiation steps. Specifically, according to independent claim 3, the invention specifies:

wherein the polycrystalline semiconductor thin film is formed by a plurality of laser irradiation steps, wherein the laser irradiation steps are carried out so that, after the last laser irradiation step, the number of crystal grains with the number of closest crystal grains of 6 is greatest among plural crystal grains that form the polycrystalline semiconductor thin film.

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The polycrystalline semiconductor thin film defined in claim 3 is characteristically structured such that those crystal grains thereof with the number of closest crystal grains numbering six represents the largest lot of the same type of crystal grains that form the polycrystalline semiconductor thin film, upon completion of the last laser irradiation step in the manufacture thereof, as is specifically called for in the following recitation:

wherein...after the last laser irradiation step, the number of crystal grains with the number of closest crystal grains of 6 is greatest among plural crystal grains that form the polycrystalline semiconductor thin film.

For example, a transistor such as a TFTs, according to the present Invention, uses a polycrystalline semiconductor thin film structured such that the largest lot of crystal grains is characterized by crystal grains with the number of closest crystal grains thereto being six. This leads to an improved construction which is, for example, suitable for obtaining uniformity as well as good carrier mobility in connection with a polycrystalline semiconductor thin film. Applicants submit, that they are the first to have achieved a schemed semiconductor device calling for a polycrystalline semiconductor thin film where a plurality of transistors are formed and which features a crystal grain structural characteristic as that presently set forth.

With regard to their investigative studies, as is explained in connection with Fig. 19 of the drawings, which typifies an arrangement of crystal grains associated with a known polycrystalline semiconductor thin film substrate used for the manufacture of TFTs, it is noted that the crystal grains thereof include varied shapes, such as trigonal (triangle), tetragonal, pentagonal, hexagonal, heptagonal and octagonal shapes, in which the hexagonal crystal grains 251 are most predominant. The present inventors studied the distribution of the types of crystal grain shapes

associated with such a polycrystalline semiconductor thin film. Even though the hexagonal crystal grains are the most predominant, in order to obtain a semiconductor film with a more favorable carrier mobility and less variation in carrier mobility in each of the regions, the inventors examined the relation between that of the energy density of a laser being irradiated to a silicon film including the number of times of effecting laser irradiation and that of the shapes of crystal grains. As a result of such investigative efforts, they were able to achieve the present invention in which a key aspect thereof calls for the number of crystal grains with the number of closest crystal grains of 6 is greatest among the plural grains that form the polycrystalline semiconductor thin film.

A key outcome of a crystal grain characteristic and arrangement thereof of an improved polycrystalline semiconductor thin film according to the present invention leads to improvement in the uniformity of the surface of the polycrystalline semiconductor thin film, and an increase in the hexagonal crystal grains from the number typically associated with manufacture of polycrystalline semiconductor thin films according to known, prior art schemes. An example of an hexagonal crystal grain formation in a polycrystalline semiconductor thin film which shows the joining of respective sides of adjacent hexagonal crystal grains can be seen with regard to Fig. 9(b) of the drawings (see also Fig. 5 as well as Fig. 8(b)).

It is emphasized that the desired construction of a polycrystalline semiconductor thin film which is used for forming the plurality of transistors of the set forth semiconductor device is only formed after plural laser irradiation steps are completed (see page 22, lines 7-22, of the present specification). For example, regarding disclosed embodiment 1, the laser beam irradiation is effected in two steps

including a first excimer laser irradiation (e.g., 604 in Fig. 1) which is followed by a second excimer irradiation (e.g. 605). Discussion related thereto is given on page 24, lines 17, *et. seq.* and Figs. 2, 10 and 11. Additional discussion regarding the achieved arrangement of the crystal grains with the number of closest crystal grains of six representing the largest lot among the plural grains that form the polycrystalline semiconductor thin film and which leads to the formation of a polycrystalline semiconductor thin film having good uniformity, as well as good carrier mobility, is found, for example, from page 18, line 10, to page 26, line 16, of the present specification. It is submitted, such a structured semiconductor device as that set forth in independent claim 3 was neither disclosed nor could have been suggested from Noguchi et al.

Noguchi et al, it is observed, showed particular interest in techniques for forming a semiconductor material with a structural arrangement featuring a plurality of substantially single-crystal grains, these crystal grains being preferentially oriented in a common surface orientation. For example, the semiconductor material is made of substantially single crystalline semiconductor crystal grains (e.g., 3a in Figs. 1-2, 10, 11 and 12) which are preferentially oriented in a common surface orientation such as {100}, {111} or {110} orientation (see the Abstract and col. 1, lines 41-46 and 56-57). It is observed, also, Noguchi et al prefer the construction of a semiconductor material with preferentially oriented and uniform grain construction leading to the substantially single-crystalline semiconductor.

It is also observed that Noguchi et al appear to show no interest in experimenting with a polycrystalline semiconductor material (see col. 1, lines 26-31). In this regard, it is noted that all four of Noguchi et al's disclosed embodiments

feature a semiconductor material with an arrangement of crystal grains that have a uniform preferential orientation leading to a substantially single crystalline semiconductor, which is in clear contradistinction of that according to the present invention. In Noguchi's first embodiment, it is noted that the semiconductor film has an arrangement of crystal grains that are preferentially {100}-oriented (see col. 3, lines 22-25, and Figs. 1-2 of Noguchi et al.). Regarding Noguchi et al's second disclosed embodiment, such as shown in Fig. 10, the semiconductor material has an arrangement of crystal grains that are preferentially {111}-oriented. (Col. 5, lines 20-34, in Noguchi et al.) Regarding Noguchi et al's third disclosed embodiment, the semiconductor film is made of substantially single-crystal grains 3a which are preferentially {100}-oriented. (Col. 5, lines 35-56, and Fig. 11 in Noguchi et al.) Likewise, the fourth disclosed embodiment of Noguchi et al also shows a semiconductor film which features a uniform single-crystalline characteristic of the semiconductor film 3. Specifically, in this embodiment, "the quasi-static single crystalline Si film 3 is made of hexagonal substantially single-crystalline crystal grains 3a which are preferentially {110}-oriented...". (Col. 5, line 57 to col. 6, line 5, and Fig. 12 in Noguchi et al.)

It is clearly apparent that Noguchi et al neither disclosed nor suggested the formation of a polycrystalline semiconductor thin film with a characteristic crystalline arrangement as that presently set forth, namely, wherein the laser irradiation steps are employed in connection with the formation of a polycrystalline semiconductor thin film such that **after the last laser irradiation step, the number of crystal grains with the number of closest crystal grains of six is greatest among plural crystal grains that form the polycrystalline semiconductor thin film.** As is

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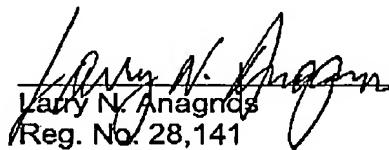
evidenced from Noguchi et al's disclosure, especially when considering the four disclosed embodiments therein, Noguchi et al's technique focuses especially on achieving a common preferential orientation of a semiconductor material with a plurality of substantially single-crystalline crystal grains of a semiconductor. For at least the above reasons, the invention according to claim 3 could not have been anticipated nor, for that matter, realizable in view of Noguchi et al.

Therefore, withdrawal of the outstanding rejection as well as early allowance of the above-identified application is respectfully requested.

To the extent necessary, Applicants petition for an extension of time under 37 C.F.R. §1.136. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to the firm of Antonelli, Terry, Stout & Kraus, LLP, Deposit Account No. 01-2135 (Docket No. 520.41003X00), and please credit any excess fees to such Deposit Account.

Respectfully submitted,

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